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ABSTRACT

This project was designed to: (1) examine the use of the computer as a tool for simulation; (2) let students gather data, analyze hypotheses, and explore algorithms; and (3) explore the potential of high resolution graphics and large memory that will characterize the microcomputers of the 1980s. Prototypes for three different computer-based instructional units (each consisting of software, student guide, and teacher's guide) were developed. The prototypes were tested during their development in special workshops for high school students and teachers. A 15 minute videotape was also prepared to illustrate the design, use, and evaluation of these prototype materials. This report on the project includes discussions of project objectives; general software design; project evaluation; staff considerations; dissemination efforts; future plans; and budget considerations. Topic areas of the prototype software include: (1) queueing theory (simulation of data collection); (2) mathematical modeling (simulation of a bouncing ball); and (3) a series of muSimp programs that provide the calculation tools for exploring elementary number theory. Findings (among others) indicate that students did not work well with lengthy or complex study guides and that more able students needed more open-ended suggestions for their own exploration. (Evaluation and budgetary summaries are provided in appendices.) (JN)

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Final Project Report

NSF/NIE Project No. SED 8012463

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The St. Olaf College project on the improvement of mathematics education using computer technology was awarded during the summer of 1980 for the three year period 1 July 1980 - 30 June 1983. During the project we developed prototypes for three different computer-based instructional units, each consisting of computer software, student guide, and teacher's guide. The prototypes were tested during their development in classes at Northfield High School, and in special workshops held at St. Olaf for high school students and teachers from surrounding communities. A 15 minute video tape was prepared to illustrate the design, use, and evaluation of these prototype materials. Copies of the project materials and the videotape are being sent under separate cover as supplements to this report.

Objectives

Our project had two principle objectives. First, we wanted to use the computer as a tool for simulation, to let the student gather data, analyse hypotheses, and explore algorithms. Second, we intended to explore the potential of high resolution graphics and large memory that will characterize the microcomputers of the '80s.

We wrote our proposal at the very beginning of the decade of the '80s, in an environment of unremitting criticism of the quality of educational software. Classroom computing was shifting from time-sharing to 8 bit Apple II and TRS-80 Model I, typically with just 16 or 32K. Programming was unimaginative ("electronic page turning") and hardware was inadequate for effective representation of high school mathematics. In forward looking states like Minnesota, organizations such as MECC (Minnesota Educational Computing Consortium) were filling a vacuum in leadership as teachers and public groped for quality in educational computing.

Now, three and a half years later, the world of microcomputers is dominated by a new generation of 16 bit machines led by IBM: memory is often ten times as large as just three years ago, good quality graphics is the rule rather than the exception, and powerful computer tools for word processing

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and spread sheet analyses are advertised in the daily papers. The explosion in the private computer marketplace has been so great that MECC, for example, has lost its government support.

As we predicted when we wrote our proposal, the marketplace has indeed provided the hardware needed for serious educational software for high school mathematics. Our prototypes, although implemented on older equipment, are ideally suited to the emerging generation.

General Design

Each of our computer programs is designed for use in high school mathematics classes, primarily in the junior and senior years. The software is written for the Heath/Zenith personal computer, a Z-80 based system with 64K memory and a single (self-contained) disk drive. The prototypes are written in various languages--Microsoft Basic, C/80, muSimp (a variation of Lisp), and the Heath assembler.

The programs we produced are not action games, but devices for aiding in the arduous job of data analysis and symbolic reasoning. Their purpose is neither to entertain nor to educate, but to provide a simple classroom alternative to real data collection and analysis. The student learning that derives from these programs depends primarily on exercises outlined by the teacher--suggested in our teacher notes--for using this data to prepare graphs, make predictions, analyse curves, and explore conjectures.

Despite their differences, our three prototypes have several things in common. Each consists of several linked programs on one or more disks for the H89 microcomputer. Each comes with instructions for preparation and use, for how programs should be linked for the purpose of typical use. Although typical users will not need to use the source code, we are prepared to provide sources for anyone interested in the details of programming. Each prototype comes with brief student notes that contain essential information for using the programs, as well as a detailed instructor's guide that offers suggestions for use, for class assignments, and example worksheets for such things as data collection.

WAIT: An Investigation of Queueing Theory

The first of our prototypes, called WAIT, consists of two simulations for data collection: BARBER and CAR WASH. Each of these simulates the familiar problem of waiting in line, and provides options for setting parameters in order to test out the efficiency of different methods of operation.

BARBER and CAR WASH are written in Microsoft Basic under the Heath Disk Operating System HDOS, using the Heath H89 block graphics for illustration and screen display. Their primary function is to simulate waiting processes under different hypotheses, to gather the data, and prepare them for student analysis. Each program uses a data file that can be set up by a special program on the teacher's master disk. This makes it possible for the teacher to tailor a particular class assignment to a special purpose and have all students working on the same type of problem, or to provide individualized projects for different students. The instructor's guide not only provides details on using the software, but also numerous suggestions for classroom activities, problems, and projects.

The programs follow the same basic format: they have a visual display showing customers entering, being served, and exiting a queueing system, and they collect data on customer arrival distributions which are used to generate the data for student analysis. In addition, each program provides the operator with several options which can be chosen according to the purposes of the simulation run: printing of inter-arrival times; printing of summary statistics; extended run without visual display (for long simulations); frequency histograms, with or without overlays of theoretical probability distributions.

Both simulations allow the option of choosing the distributions for arrival times and service times. The time between arrivals can be constant (for example, haircuts by appointment only), normally distributed (a more realistic appointment situation) or exponentially distributed (to simulate random arrivals).

The barber in BARBER works by himself (single server) and has two chairs for customers to wait in. Customers are seen to arrive at the door, hesitate and then move into the first empty chair. If there are no empty chairs they will leave. (To add interest to the display, an occasional person simply walks by the door without attempting to enter. These passers-by are not counted in any of the data collection activities.)

Changes that can be made to this model--at the instructor's option--are the addition of up to five more barbers and ten more chairs to allow study of parallel servers. The normal investigations of waiting time, queue length, and traffic intensity can be made, as well as determination of the number of customers turned away.

CAR WASH is a single server system with an exponential arrival pattern and a constant rate of service. The teacher or student can determine the mean inter-arrival time and the length of service; the name of the car wash reflects the service time (e.g., "5-Minute Car Wash"). It can be used to investigate waiting times, queue lengths, and traffic intensity.

An optional feature of Car Wash is the addition of either a vacuum bay before the wash or a buffer facility after it. The vacuum bay operates on a normal service distribution while the buffer unit has an exponential service pattern. In addition to increasing the complexity of the system, the use of an additional facility in series allows investigation of blockage of a queue, which occurs when the queue between the first and second bay is full so that a customer may not leave the first bay even though he is finished.

BOUNCE: A Study of Mathematical Modelling

Our second prototype simulates a falling object that hits the ground and bounces repeatedly according to a user-controlled parameter that determines the elasticity. The BOUNCE program employs a special Maxtek graphics board in the H89 microcomputer that makes it possible to address individual pixels. This exploration was part of our effort to develop right now software for microcomputers that will be common five years from now. (These predictions have proven quite accurate: most of the new 16 bit personal computers are coming with pixel-addressing graphics as a standard feature.)

In order that BOUNCE would operate at realistic speed--rather than just in disconcertingly slow motion--we programmed it in C, using the software development tools available on St. Olaf's UNIX PDP 11/70 academic computer. The code was then compiled in C/80 to run on the Heath H89 under the HDOS operating system.

Because the mathematics involved in a falling body is closer to the models ordinarily encountered in school mathematics, the student and teacher guides for this prototype need not be as elaborate as those for the waiting line simulation. However, the general objectives and use of the simulation are similar: to gather data--on time of fall, on velocity of the ball, on height of bounce, on number of bounces--and then analyse it. This leads immediately to graphs of linear, quadratic and exponential relationships, and their associated equations.

A simple change of parameters will shift the simulation from earth to the moon, for example, or to Jupiter if the student wishes; leading questions in the student guide suggest comparative simulations that will reveal the effect of different planetary masses on the speed of fall.

Other parameters deal with air resistance (on the different planets) and with different types of balls (ping pong, softball, basketball, super ball, marble, etc.). Models near the end of this unit deal with terminal velocity for skydivers and raindrops.

The student guide provides suggestions for various simulations to provide a quasi-empirical investigation; the teacher's guide provides the relevant mathematics which could be used by advanced students for project work. BOUNCE has the same type of data-setting capabilities available to the teacher as do BARBER and CAR WASH.

NUMBER: An Exercise in Detecting Patterns

Our third prototype is distinctly different from the first two. It is not a simulation, but an exploration of one of the major existing software tools available for mathematics education: muMath, the Symbolic Algebra Package. This package is written in muSimp, a variant of Lisp; our programs are written in muSimp to extend the basic options of the muMath package. NUMBER, our package of enhanced muSimp programs, runs under the CP/M operating system on the Heath H89 microcomputers.

The package is a microcosm of artificial intelligence, with capability for dealing symbolically (rather than numerically) with most of the mathematics in high school and beginning college classes. The emphasis on induction, on symbolic manipulation, and on user-defined functions provides a striking contrast to simulation, data collection and mathematical modelling. By using this package, a teacher can employ tools ordinarily unavailable in a mathematics classroom: rapid calculation in various number bases; exploration of large numbers (up to 600 digit accuracy); solution of equations in symbolic form; iterative calculations with exact precision (e.g., for binomial coefficients).

NUMBER consists of a series of muSimp programs that provide the calculation tools for exploring elementary number theory--patterns of prime numbers, different number bases, Fibonacci and perfect numbers, and "churn", the famous "3n+1" algorithm that leads to a curently unsolved problem in number theory. The accompanying student guides suggest hand-calculation of small examples, followed by muMath runs for larger numbers.

Since the programs involved in this unit are very short--being essentially subroutines for the existing large muMath package--several exercises suggest that students modify these subroutines for their own purposes. They need not know anything about programming to make slight changes in these routines, and the experience may lead to considerable exploration of muMath beyond the suggestions contained in NUMBER itself.

The teachers's guide provides additional background on the various topics treated by NUMBER, as well as suggestions for dealing with muSimp and muMath.

Development Process

The prototypes were developed according to the plan laid out in our proposal: initial design by a team including a teacher in the Northfield High School; software development by staff and student programmers at St. Olaf College; student and teacher's guides written by Associate Project Director Martha Wallace; field testing with local high school students, and revision based on these field tests. Naturally, the earlier units (BARBER and CAR WASH) are now more refined than the last one (NUMBER), but each has been through at least one round in the design-test-revise cycle.

Each of the three prototypes is written in a different language: WAIT in MicroSoft Basic, BOUNCE in C, and NUMBER in muSimp. Because of the nature of the languages, the Basic and muSimp source code is provided on the prototype disks, and is available to be modified if necessary by the user. The C code is too large to be worked with on microcomputer disks--it takes up nearly 200 pages of printout--but can be stored and transmitted on disk. The prototype disks for this unit use the compiled code --to achieve the speed of the bouncing simulation.

An important part of our project was the development of extensive student and teacher guides for each unit; indeed, the effort that went into preparing guides was at least as great as the programming part of our work. So each unit has two guides, a short one for students and a more detailed one for teachers.

Evaluation

Project evaluation consisted of several different activities. The Project Director was actively involved in evaluating initial design options, especially as they effected the linkage of hardware with software. (Details of these considerations are given in the First Year Project Report.) Throughout, the Director was involved in evaluating and monitoring project progress, to insure proper timing and coordination of the various units.

The evaluation of of the computer units themselves was carried out primarily in high school classrooms and in the computer workshops organized to field-test the material. Data was collected from students in several forms: a simple test of computer literacy excerpted from the MECC Computer Literacy Survey; a running commentary kept by the assistant in each session, providing space for "situation", "student comment or question", and "help offered"; and a final evaluation form. (Summmaries of these evaluations are appended to this report as Appendix A.)

Results of these evaluations were used to revise the programs. Among the things we learned were that students did not

work well with lengthy or complex study guides (better to leave all advanced material in the teacher's guide), that more able students need more open-ended suggestions for their own exploration, and that teachers needed more help in learning how to take advantage of the computer simulations. The workshops also showed that students work best at this type of experimentation in groups of two or three, and that hand calculation should precede computer simulation for thorough understanding. These findings were subsequently incorporated into revisions of the teacher and student guides.

The Associate Project Director was responsible for conducting and reacting to these formative evaluations. Both software and guides were revised in response to problems that were detected in the formative stage.

Staff

The principle members of the project staff worked together throughout the three years of this project: Project Director Lynn Steen, Associate Project Director Martha Wallace, and Academic Programmer Peter Berger. As reported in our second annual report, Dan Klassen who was involved in development of the initial evaluation instruments resigned from St. Olaf in the middle of the project; his duties were assumed by Alice Thomas, Director of the Office of Educational Research.

Dissemination

In October 1982 we sent a three page "Project Status Report" to all project directors of similar DISE/RISE grants, as well as to educators, mathematicians, and software developers who had written for information. This mailing included over 300 names. We will send a similar mailing with a summmary of this Final Report to the same individuals.

In April 1982 the Associate Project Director gave a presentation at the Annual Meeting of the National Council of Teachers of Mathematics in Toronto. In addition, references to this project appeared in papers written by both the Project Director and Associate Project Director during the course of the grant:

Lynn Arthur Steen. "Linking Microcomputers to TimeSharing Systems: Efficient Computing in a Liberal Arts Environment." Proceedings of the 1982 National Educational Computing Conference, 1982.

Lynn Arthur Steen and J. Arthur Seebach. "Using Microcomputers as Satellites in a Time-Sharing Environmment." Proceedings of the 1982 National ACM Conference," 1982.

Lynn Arthur Steen. "Heathkit Haven at St. Olaf." Sextant, Fall, 1983.

Martha Wallace. "Queueing: Development of a Computer Simulation Unit." M. A. Thesis, University of Minnesota, 1983.

Martha Wallace. "Problem Solving + Application + Technology = Computer Simulation." 1985 Yearbook of the National Council of Teachers of Mathematics, (Forthcoming).

In addition, the Associate Project Director demonstrated these materials in several regional meetings, and used them for a summer workshop for high school teachers in June, 1983.

Future Plans

We have initiated correspondence with software publishers to determine if there is interest in commercial distribution of these materials, suitably modified to other computers and operating systems. It is still too early to say what will emerge in this area.

Our project team has submitted two different proposals to NSF to continue work initiated by this project, but in quite different directions: one is for continued honors workshops for high school teachers in which these materials along with others can be used, the other is to develop computer materials for COMAP modules at the high school level, building on the organizational and software development experience of this project.

Finally, whether or not additional funds become available, we intend to translate these materials to the new IBM PC standard so that they can readily be used on the numerous IBM-like machines that are in today's micocomputer market. This standard epitomizes the target of large memory and quality graphics that we established for the prototype units.

Budget

The following pages contain the final budget report for our project, giving first the NSF supported expenditures, then the St. Olaf matching contributions, and finally the total project expenses. In each case the annual expenditures are listed together with a three-year total, as well as a record of the original budget.

Summary of NSF Project Expenses

(1 July 1981 - 30 Sept. 1983)

	Expenses 1980-81	Expenses 1981-82	Expenses 1982-83	Total Expenses 1980-83	3-Year Budget
Project Director	2400.00	3600.00		6000.00	6000.00
Assoc. Proj. Dir.	3013.48	2128.16	1275.00	6416.64	7650.00
Evaluator					
Acad. Programmer	654.17	3284.56		3938.73	4000.00
Stud. Programmer		2359.24	3201.88	5561.12	2400.00
Secretary					200.00
Fringe Benefits	459.28	520.06	200.59	1179.93	2640.00
Total Wages & Ben.	6526.93	11892.02	4677.47	23096.42	22890.00
Hardware		8882.59	5382.75	14265.34	11700.00
Software	29.95	444.81	746.80	1221.56	1300.00
Travel	681.93	332.75		1014.68	1500.00
Printing			479.47	479.47	500.00
Consultants		200.00	1569.75	1769.75	2250.00
Telephone, Dupl.	65.44	519.50	416.14	641.08	800.00
Direct Costs	7304.25	21911.67	13272.38	42488.30	40940.00
Indirect Costs		6600.00	5095.70	11695.70	13244.00
Total Proj. Costs	7304.25	28511.67	18368.08	54184.00	54184.00

Summary of NSF Project Expenses
(1 July 1981 - 30 Sept. 1983)

Summary of St. Olaf Matching Contributions

(1 July 1981 - 30 Sept. 1983)

	Expenses 1980-81	Expenses 1981-82	Expenses 1982-83	Total Expenses 1980-83	3-Year Budget
Project Director					
Assoc. Proj. Dir.			3750.00	3750.00	2550.00
Evaluator		1500.00	300.00	1800.00	3000.00
Acad. Programmer					
Stud. Programmer					
Secretary			400.00	400.00	400.00
Fringe Benefits					
Total Wages & Ben.		1500.00			5950.00
Hardware	3905.29			3905.29	3900.00
Software					
Travel					
Printing					
Consultants					
Telephone, Dupl.					
Direct Costs	3905.29	1500.00	4450.00	9855.29	9850.00
Indirect Costs		981.00	2648.70	3629.70	3891.00
Total Proj. Costs	3905.29	2481.00	7098.70	13484.99	13741.00

Summary of St. Olaf Matching Contributions
(1 July 1981 - 30 Sept. 1983)

Summary of Total Project Expenses

(1 July 1981 - 30 Sept. 1983)

	Total Expenses 1980-81	Total Expenses 1981-82	Total Expenses 1982-83	Total Expenses 1980-83	Total Budget
Project Director	2400.00	3600.00		6000.00	6000.00
Assoc. Proj. Dir.	3013.48	2128.16	5025.00	10166.64	10200.00
Evaluator	.00	1500.00	300.00	1800.00	3000.00
Acad. Programmer	654.17	3284.56		3938.73	4000.00
Stud. Programmer	.00	2359.24	3201.88	5561.12	2400.00
Secretary	.00	.00	400.00	400.00	600.00
Fringe Benefits	459.28	520.06	200.59	1179.93	2640.00
Total Wages & Ben.	6526.93	13392.02	9127.47	29046.42	28840.00
Hardware	3905.29	8882.59	5382.75	18170.63	15600.00
Software	29.95	444.81	746.80	1221.56	1300.00
Travel	681.93	332.75		1014.68	1500.00
Printing	.00	.00	479.47	479.47	500.00
Consultants	.00	200.00	1569.75	1769.75	2250.00
Telephone, Dupl.	65.44	159.50	416.14	641.08	800.00
Direct Costs	11209.54	23411.67	17722.38	52343.59	50790.00
Indirect Costs		7581.00	7744.40	15325.40	17135.00
Total Proj. Costs	11209.54	30992.67	25466.78	67668.99	67925.00

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Summary of Total Project Expenses
(1 July 1981 - 30 Sept. 1983)

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Appendix A: Evaluation Summaries

FREQUENCY DISTRIBUTIONS FOR ITEMS IN THE COMPUTER WORKSHOP EVALUATION

October 1982

(n=114)

Math Class

	n	%
Precalculus	74	66.1
Senior Math	38	33.9
No Response	2	

Workshop Group

	n	%
Group A	55	49.1
Group B	57	50.9
No Response	2	

Heathkit Programs Used By Students

	BARBER (n=77)				BOUNCE (n=105)				MUMATH (n=113)			
	True		False		True		False		True		False	
	n	%	n	%	n	%	n	%	n	%	n	%
1. I used this program. (Do not answer the rest of the questions for a program if you did not use it.	77	67.5	37	32.5	105	92.1	9	7.9	113	99.1	1	.9
2. Using a computer is an enjoyable way to study this topic.	73	96.1	3	3.9	102	98.1	2	1.9	93	83.8	18	16.2
3. I feel that I could learn more from an actual experiment.	26	33.8	51	66.2	38	36.9	65	63.1	50	45.5	60	54.5
4. It was hard to remember which commands the computer understood.	11	14.7	64	85.3	13	12.5	91	87.5	53	47.7	58	52.3
5. I would like to use this program again.	60	76.9	18	23.1	82	78.1	23	21.9	78	69.6	34	30.4
6. The assignment was too easy for me.	19	25.3	56	74.7	40	38.8	63	61.2	20	18.2	90	81.8
7. I felt that I was in control of the program.	58	75.3	19	24.7	91	87.5	13	12.5	62	55.9	49	44.1
8. There were some new ideas for me here.	66	86.8	10	13.2	86	82.7	18	17.3	97	85.8	16	14.2
9. I see some practical applications for the things I learned.	66	85.7	11	14.3	72	70.6	30	29.4	84	76.4	26	23.6
10. The instructions in the program were clear.	68	88.3	9	11.7	93	90.3	10	9.7	72	64.3	40	35.7
11. The program was easy to use.	71	93.4	5	6.6	100	95.2	5	4.8	72	65.5	38	34.5
12. I would like more lessons like this.	62	80.5	15	19.5	83	79.8	21	20.2	76	70.4	32	29.6
13. I would rather learn the material some other way.	11	14.3	66	85.7	14	13.3	91	86.7	33	29.7	78	70.3
14. As a change of pace this lesson was welcome.	75	97.4	2	2.6	101	96.2	4	3.8	108	96.4	4	3.6

Office of Educational Research

November 1982

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FREQUENCY DISTRIBUTIONS FOR ITEMS IN THE
COMPUTER WORKSHOP PRE-TEST
October 1982
(n=113)

Math Class

	n	%
Precalculus	73	64.6
Senior Math	40	35.4

	Strongly Disagree		Disagree		Undecided		Agree		Strongly Agree	
	n	%	n	%	n	%	n	%	n	%
1. I would like to learn more about computers..	1	.9	1	.9	5	4.4	41	36.3	65	57.5
2. Working with a computer would probably make me feel uneasy or tense.....	29	25.7	44	38.9	22	19.5	15	13.3	3	2.7
3. I feel helpless around a computer.....	14	12.4	40	35.4	18	15.9	35	31.0	6	5.3
4. Computers sometimes scare me.....	41	36.3	43	38.1	13	11.5	13	11.5	3	2.7
5. I would very much like to have my own computer.....	2	1.8	4	3.5	25	22.1	36	31.9	46	40.7
6. I would like the idea of taking computer courses.....	2	1.8	1	.9	25	22.1	51	45.1	34	30.1
7. I enjoy using computers in my classes.....	1	.9	7	6.3	41	36.6	44	39.3	19	17.0
8. Walking through a room filled with computers would make me feel uneasy.....	38	33.6	49	43.4	11	9.7	12	10.6	3	2.7
9. I feel uneasy when I am with people who are talking about computers.....	15	13.4	43	38.4	30	26.8	21	18.8	3	2.7
10. I enjoy working with computers.....	2	1.8	6	5.3	30	26.5	54	47.8	21	18.6
11. I feel confident about my ability to use computers.....	19	16.8	41	36.3	26	23.0	21	18.6	6	5.3
12. It is my guess that I am not the kind of person who works well with computers.....	24	21.2	41	36.3	29	25.7	18	15.9	1	.9
13. On the whole, I can cope with computers in my daily living.....	4	3.5	9	8.0	18	15.9	62	54.9	20	17.7
14. I am able to work with computers as well as most others my age.....	6	5.3	35	31.0	37	32.7	20	17.7	15	13.3
15. Computers are gaining too much control over people's lives.....	13	11.5	44	38.9	28	24.8	19	16.8	9	8.0
16. In general, females can do just as well as males in computer specialists.....	6	5.3	6	5.3	10	8.8	29	25.7	62	54.9
17. More females than males have the ability to become computer specialists.....	43	38.1	30	26.5	36	31.9	1	.9	3	2.7
18. Using computers is more for males than for females.....	52	46.0	35	31.0	17	15.0	3	2.7	6	5.3
19. Studying about computers is just as important for females as for males.....	7	6.2	1	.9	7	6.2	34	30.1	64	56.6
20. Men make better scientists and engineers than women do.....	53	46.9	25	22.1	11	9.7	14	12.4	10	8.8
21. Falsifying information in computers is a serious crime.....	5	4.4	6	5.3	32	28.3	31	27.4	39	34.5
22. Access to personal information in computer files is a serious problem.....	-	-	7	6.2	41	36.3	35	31.0	30	26.5
23. Organizations should not be allowed to create secret computer files containing detailed information regarding people's personal lives	8	7.1	17	15.0	37	32.7	28	24.8	23	20.4

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Frequencies - Computer Workshop Pre-Test 2

	Strongly Disagree		Disagree		Undecided		Agree		Strongly Agree	
	n	%	n	%	n	%	n	%	n	%
24. Because of computerized information files, too many people have information about other people.....	5	4.4	15	11.3	57	50.4	31	27.4	5	4.4
25. To protect people's privacy it is necessary to have laws regarding computer files that contain personal data.....	1	.9	-	-	23	20.4	62	54.9	27	23.9
26. Every secondary school student should have some minimal understanding of computers....	2	1.8	4	3.5	2	1.8	48	52.5	57	50.4
27. Every secondary school student should learn about the role that computers play in our society.....	2	1.8	3	2.7	9	8.0	57	50.4	42	37.2
28. Every secondary school student should be able to write a simple program.....	3	2.7	4	3.5	14	12.4	54	47.8	38	33.6
29. Computers can be a useful instructional aid in many subject areas other than mathematics.....	1	.9	2	1.8	-	-	51	45.1	59	52.2
30. Computers provide more disadvantages than advantages in education.....	44	38.9	45	39.8	20	17.7	3	2.7	1	.9

Circle one alternative for each of the eight adjectives:

COMPUTERS ARE:

		n	%
1.	a. not personal	52	46.0
	b. personal	26	23.0
	c. very personal	4	3.5
	d. undecided	31	27.4
2.	a. not frustrating	30	26.5
	b. frustrating	52	46.0
	c. very frustrating	7	6.2
	d. undecided	24	21.2
3.	a. not good	2	1.8
	b. good	56	49.6
	c. very good	49	43.4
	d. undecided	6	5.3
4.	a. not humanizing	40	35.4
	b. humanizing	16	14.2
	c. very humanizing	3	2.7
	d. undecided	54	47.8
5.	a. not challenging	-	-
	b. challenging	53	46.9
	c. very challenging	57	50.4
	d. undecided	3	2.7
6.	a. not bad	97	85.8
	b. bad	3	2.7
	c. very bad	1	.9
	d. undecided	12	10.6
7.	a. not impersonal	17	15.0
	b. impersonal	40	35.4
	c. very impersonal	16	14.2
	d. undecided	40	35.4
8.	a. not dehumanizing	33	29.2
	b. dehumanizing	20	17.7
	c. very dehumanizing	11	9.7
	d. undecided	49	43.4

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Frequencies - Computer Workshop Pre-Test 3

1. Computers cannot be used to assist in teaching English grammar.

n	%	
9	8.0	true
96	85.0	false
8	7.1	I don't know

2. Computers are not really used very much yet except by scientists.

2	1.8	true
110	97.3	false
1	.9	I don't know

3. People often use computers to store large amounts of information they wish to use over and over again.

111	89.2	true
1	.9	false
1	.9	I don't know

4. Computers help people make decisions by providing correct answers to any question.

18	15.9	true
81	71.7	false
14	12.4	I don't know

5. Use of computers in education always results in less personal treatment of students.

25	22.1	true
64	56.6	false
24	21.2	I don't know

6. In order to use a computer you would have to be in the same building as the computer.

7	6.2	true
102	90.3	false
4	3.5	I don't know

7. Computers are able to think in every way just like people.

1	.9	true
104	92.0	false
8	7.1	I don't know

8. Using computers can free one to do more creative tasks, but this may lead to more dependence upon machines.

80	70.8	true
16	14.2	false
17	15.0	I don't know

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9. In order to use a computer a person must know how to program.

n	%	
22	19.3	true
81	71.7	false
10	8.8	I don't know

10. A basic use for computers in the design of airplanes is:

59	52.7	simulation and modelling
8	7.1	process control
9	8.0	making reservations
3	2.7	keeping inventory
33	29.5	I don't know

11. Which of the following is a limiting consideration for using computers?

15	13.3	cost
4	3.5	software availability
3	2.7	storage capacity
76	67.3	all of the above
15	13.3	I don't know

12. When in operation, a computer:

79	69.9	follows a set of instructions written by people
1	.9	thinks just like a person
11	9.7	recalls answers from memory
2	1.8	translates data from digital to analog code
20	17.7	I don't know

13. Computers <u>cannot</u> run without:

1	.9	blinking lights
7	6.3	keyboards
81	73.0	instructions
10	9.0	all of the above
12	10.8	I don't know

14. At any given moment, a computer's memory unit can store:

4	3.6	programs
5	4.5	data
-	-	answers
95	84.8	all of the above
8	7.1	I don't know

15. A computer program is a:

-	-	course on computers
102	91.1	set of instructions to control the computer
5	4.5	computer generated presentation
-	-	piece of computer hardware
5	4.5	I don't know

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FREQUENCY DISTRIBUTIONS FOR ITEMS IN THE
COMPUTER WORKSHOP POST-TEST
October 1982
(n=114)

Math Class	n	%
Precalculus	75	65.8
Senior Math	39	34.2

	Strongly Disagree		Disagree		Undecided		Agree		Strongly Agree	
	n	%	n	%	n	%	n	%	n	%
1. I would like to learn more about computers..	2	1.8	1	.9	1	.9	44	38.6	66	57.9
2. Working with a computer would probably make me feel uneasy or tense.....	41	36.0	48	42.1	16	14.0	7	6.1	2	1.8
3. I feel helpless around a computer.....	29	15.4	59	51.8	12	10.5	13	11.4	1	.9
4. Computers sometimes scare me.....	39	34.2	48	42.1	14	12.3	12	10.5	1	.9
5. I would very much like to have my own computer.....	3	2.6	3	2.6	12	10.5	38	33.3	58	50.9
6. I would like the idea of taking computer courses.....	4	3.5	1	.9	18	15.8	49	43.0	42	36.8
7. I enjoy using computers in my classes.....	5	4.4	5	4.4	11	9.6	54	47.4	39	34.2
8. Walking through a room filled with computers would make me feel uneasy.....	51	45.1	49	43.4	9	8.0	1	.9	3	2.7
9. I feel uneasy when I am with people who are talking about computers.....	17	14.9	52	45.6	25	21.9	18	15.8	2	1.8
10. I enjoy working with computers.....	3	2.7	2	1.8	4	3.5	71	62.8	33	29.2
11. I feel confident about my ability to use computers.....	6	5.3	24	21.2	26	23.0	45	39.8	12	10.6
12. It is my guess that I am not the kind of person who works well with computers.....	30	26.3	50	43.9	20	17.5	11	9.6	3	2.6
13. On the whole, I can cope with computers in my daily living.....	2	1.8	4	3.5	14	12.4	68	60.2	25	22.1
14. I am able to work with computers as well as most others my age.....	3	2.6	23	20.2	24	21.1	51	44.7	13	11.4
15. Computers are gaining too much control over people's lives.....	20	17.7	48	42.5	31	27.4	10	8.8	4	3.5
16. In general, females can do just as well as males in computer specialists.....	10	8.8	3	2.6	11	9.6	28	24.6	62	54.4
17. More females than males have the ability to become computer specialists.....	46	40.4	39	34.2	22	19.3	4	3.5	3	2.6
18. Using computers is more for males than for females.....	52	45.6	35	30.7	17	14.9	1	.9	9	7.9
19. Studying about computers is just as important for females as for males.....	8	7.0	2	1.8	7	6.1	36	31.6	61	53.5
20. Men make better scientists and engineers than women do.....	52	46.0	27	23.9	13	11.5	9	8.0	12	10.6
21. Falsifying information in computers is a serious crime.....	3	2.7	4	3.5	30	26.5	32	28.3	44	38.9
22. Access to personal information in computer files is a serious problem.....	1	.9	9	8.0	32	28.3	44	38.9	27	23.9
23. Organizations should not be allowed to create secret computer files containing detailed information regarding people's personal lives	6	5.3	11	9.6	35	30.7	42	36.8	20	17.5

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Computer Workshop - Post-Test 2

	Strongly Disagree		Disagree		Undecided		Agree		Strongly Agree	
	n	%	n	%	n	%	n	%	n	%
24. Because of computerized information files, too many people have information about other people.....	3	2.6	16	14.0	50	43.9	35	30.7	10	8.8
25. To protect people's privacy it is necessary to have laws regarding computer files that contain personal data.....	2	1.8	3	2.6	21	18.4	57	50.0	31	27.2
26. Every secondary school student should have some minimal understanding of computers....	1	.9	5	4.4	6	5.3	46	40.4	56	49.1
27. Every secondary school student should learn about the role that computers play in our society.....	1	.9	3	2.6	12	10.5	54	47.4	44	38.6
28. Every secondary school student should be able to write a simple program.....	2	1.8	6	5.3	14	12.3	60	52.6	32	28.1
29. Computers can be a useful instructional aid in many subject areas other than mathematics.....	1	.9	3	2.6	4	3.5	43	37.7	63	55.3
30. Computers provide more disadvantages than advantages in education.....	44	38.6	45	39.5	14	12.3	8	7.0	3	2.6

Circle one alternative for each of the eight adjectives:

COMPUTERS ARE:

		n	%
1.	a. not personal	52	46.0
	b. personal	40	35.4
	c. very personal	3	2.7
	d. undecided	18	15.9
2.	a. not frustrating	49	43.0
	b. frustrating	43	37.7
	c. very frustrating	2	1.8
	d. undecided	20	17.5
3.	a. not good	2	1.8
	b. good	61	53.5
	c. very good	43	37.7
	d. undecided	8	7.0
4.	a. not humanizing	48	42.1
	b. humanizing	22	19.3
	c. very humanizing	7	6.1
	d. undecided	37	32.5
5.	a. not challenging	6	5.3
	b. challenging	65	57.0
	c. very challenging	41	36.0
	d. undecided	2	1.8
6.	a. not bad	92	80.7
	b. bad	8	7.0
	c. very bad	1	.9
	d. undecided	13	11.4
7.	a. not impersonal	29	25.4
	b. impersonal	47	41.2
	c. very impersonal	10	8.8
	d. undecided	28	24.6
8.	a. not dehumanizing	33	28.9
	b. dehumanizing	29	25.4
	c. very dehumanizing	5	4.4
	d. undecided	47	41.2

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Computer Workshop Post-Test

n	%	
		1. Computers cannot be used to assist in teaching English grammar.
20	17.5	true
90	78.9	false
4	3.5	I don't know
		2. Computers are not really used very much yet except by scientists.
3	2.6	true
109	95.6	false
2	1.8	I don't know
		3. People often use computers to store large amounts of information they wish to use over and over again.
111	97.4	true
1	.9	false
2	1.8	I don't know
		4. Computers help people make decisions by providing correct answers to any question.
22	19.3	true
86	75.4	false
6	5.3	I don't know
		5. Use of computers in education always results in less personal treatment of students.
20	17.5	true
60	52.6	false
34	29.8	I don't know
		6. In order to use a computer you would have to be in the same building as the computer.
8	7.0	true
101	88.6	false
5	4.4	I don't know
		7. Computers are able to think in every way just like people.
3	2.6	true
107	93.9	false
4	3.5	I don't know
		8. Using computers can free one to do more creative tasks, but this may lead to more dependence upon machines.
81	71.1	true
17	14.9	false
16	14.0	I don't know

9. In order to use a computer a person must know how to program.

16	14.2	a. true
91	80.5	b. false
6	5.3	c. I don't know

10. A basic use for computers in the design of airplanes is:

71	62.5	a. simulation and modelling
8	7.0	b. process control
6	5.3	c. making reservations
2	1.8	d. keeping inventory
27	23.7	e. I don't know

11. Which of the following is a limiting consideration for using computers?

19	16.8	a. cost
5	4.4	b. software availability
4	3.5	c. storage capacity
69	61.1	d. all of the above
16	14.2	e. I don't know

12. When in operation, a computer:

91	80.5	a. follows a set of instructions written by people
2	1.8	b. thinks just like a person
7	6.2	c. recalls answers from memory
3	2.7	d. translates data from digital to analog code
10	8.8	e. I don't know

13. Computers cannot run without:

1	.9	a. blinking lights
3	2.6	b. keyboards
97	85.1	c. instructions
9	7.9	d. all of the above
3	2.6	e. I don't know

14. At any given moment, a computer's memory unit can store:

4	3.6	a. programs
7	6.5	b. data
-	-	c. answers
100	89.3	d. all of the above
1	.9	e. I don't know

15. A computer program is a:

3	2.7	a. course on computers
98	87.5	b. set of instructions to control the computer
2	1.8	c. computer generated presentation
1	.9	d. piece of computer hardware
8	7.1	e. I don't know